INTEGRATED AIR NAVIGATION AND FLIGHT CONTROL SYSTEM

The invention discloses a method and a device for an integrated air navigation and flight control system according the preamble of the independent claim.

The new air navigation and flight control system contributes to the efforts to solve air traffic congestion, improve safety, reduce human factors errors, simplifies cockpit equipment, increases capacity limitations in North Atlantic and Pacific airspace, in continental airspace and in terminal areas of airports around the world.

The new system will allow aircrafts to take advantage of reduced separation and follow optimized flight paths by using GNSS navigation. It will save time and fuel costs thus minimizing air pollution, increases aircraft utilization and brings efficiency benefits to the airlines. It is designed to minimize cockpit workload, cut interpretation time and cutout input errors e.g. caused by inadvertent entering of wrong coordinates into the aircrafts navigation system. With the integrated terrain database, controlled flight into terrain (CFIT) will be omitted. It will enable CAT I, II and III approaches to non-ILS equipped airports thereby increasing the reliability of scheduled flights and omitting costs arising with alternate landings. With its giant integration technology one is no longer forced to buy, install and maintenance many

different kind of cockpit instruments and equipment thus considerably saving the airline operators budget.

The invention is declared in connection with the following figures:

Figure 17   Screen with display of conventional engine
             instruments

Figure 18   Software: schematic dataflow room and to the device

Figure 19   Software: networking of the software modules

The new method and device is the first highly integrated system
that offers:

a. full pictorial navigation from gate to gate increasing
    flight safety on ground and in the air tremendously.

b. an integrated electronic cockpit library relieving the
    pilots from doing paper work while flying.

c. pictorial GNSS 3-D approach tunnels guiding *the pilot*
    safely down to the runway threshold.

d. CAT I, II and III precision differential GNSS approaches to
    any non-ILS equipped airfield on our globe enabling new
    destinations.

e. forward looking ground proximity warning avoiding
    controlled flight into terrain.

f. integrated collision avoidance on ground and in the air
    increasing safety for passengers, crew, aircraft and cargo.

g. an advanced PFD (Primary Flight Display) with integrated
    FMS (Flight Management System).

h. integrated flight recorder functions for safety, training
    and analysis.

i. data link for ATM (Air Traffic Management) for safe
    guidance in the air and on ground.

j. actual weather satellite pictures from *the aircraft's*
    present position, destination or any other place of
    interest.

k. moving 3-D terrain depiction hence enabling *the pilot* to
   see the terrain even the pilot are in complete IMC or at
   night. This gives *the pilot* a tremendous safety margin and
   omits CFIT.

For easier writing and reading the method and device the global
Integrated Air Navigation and Flight Control System in the
following description is shortly called "GIANS".

GIANS is compact and lightweight; compared to today's 'normal'
equipment it costs and weights only a fraction of it and needs
much the less electrical power (Figure 1). With the above
integrated unique novelties, the system is an efficient and
safe tool for professional navigation, cockpit- and flight
management (Figures 2 and 3). It provides:

- Advanced primary flight display
- Integrated electronic cockpit library
- True digitized moving maps
- Integrated coupled flight planning.
- Integrated differential GNSS receiver.
- Worldwide FMS database
- Terrain depiction and warnings
- Satellite weather picture reception
- User specific 3-D approach tunnels
- Replacement for many cockpit instruments

These are only a few of the prime advantages offered by the
unique high-tech stand alone navigation and flight control
system GIANS

In the following the features and possibilities of GIANS are
declared while operating an airplane from port to port

1. TAXI

When starting engines the system presents automatically the
taxi chart *the pilot* is used to, with position on the apron.
While taxiing out, the chart will move and turn according track
5   and position. *The pilot* sees the apron move on the display as
he would see it when looking out of *his* window. While lining
up, *the pilot* sees what runway *he is* entering.

No more worries about where *the aircraft's* stand is and which
taxiway to take on larger airports. No more accidents in foggy
10 met conditions or at night due to unintended entering of a
runway or the wrong runway. (Figure 4)

2. LINING UP AND DEPARTURE:

Select the appropriate departure chart according *the pilot*'s
15 IFR or VFR clearance. *The pilot* can read his IFR clearance on
the display. At departure the system presents automatically *the
aircraft's* track, position, altitude and elapsed time, without
touching any button. Take off time is stored and displayed. *The
pilot* only has to follow *the* departure route on the displayed
20 chart. (Figure 5)

No more airway manuals in the cockpit. No more hasty reaching
for departure charts in and out of the airway manuals. No more
loosing the sheets somewhere beneath *the pilot*'s seat, no more
attaching the sheet to *the pilot*'s steering wheel, covering
25 parts of the lower instrument panel, no more entering
coordinates and no more risk of being shot at due to navigation
error.

ENROUTE:

30 When approaching the border of the departure chart, *the pilot*'s
high- or low level enroute chart with *the airplane's* position

and track appears on the display, again without touching any button. If the pilot wishes to cancel IFR and continue VFR or vice versa *the pilot* only needs to press a button and the System will change to the appropriate maps and charts. Rotary
5   wing aircraft can operate with obstruction maps 1:100 000 or better. (Figure 6)

If the pilot has some time enroute *the pilot* may wish to study the Destination Area and approach charts, weather frequencies, or any other chart of interest; Simply change to the library
10 mode and *the pilot* has access to every map or chart or text or checklist *he* wishes.

With the weather option installed, *the pilot* has direct access to the newest satellite weather picture, independent of *the aircraft's* position, whether in the air or on ground, whether
15 on a polar flight or crossing the equator.

APPROACH:

When approaching *the* destination, *the pilot*'s area- or approach chart with *actual* position and track appears on the display
20 automatically, again without touching any button; they may also be selected manually. All *the pilot* has to do is to follow the approach line on *the* chart. If Radar permits, *the pilot* may shorten *the* approach as shown on the Figure. (Figure 7)

And finally a curved or straight 3-D approach tunnel (customers
25 option) with distances, altitudes and checkpoint marks will guide *the pilot* safely to the runway. This fine feature will enable *the pilot* to make safe approaches and go around at difficult airports, e.g. surrounded by high terrain (Figures 8-10).

30

ALTERNATE:

Should *the pilot* have to divert to *an* alternate he has just to activate, the alternate, and the appropriate charts will appear on *the pilot*'s screen.

5

ON GROUND:

When landed, the system will automatically show *the pilot* the necessary taxi charts and stands and of course *the aircraft's* position and track on the apron. Landing time and elapsed time

10   are automatically stored and displayed.

THE SYSTEMS CAPABILITIES AND FEATURES

True Mapping on the Navigation Display (ND)

15   The systems true mapping, based on GNSS, offers a fully automatic, or manual the pilot prefer, selection of any kind of real map, e.g. Taxi-, Departure, Enroute, Area, Approach and Landing charts, colored or non-colored. They are positioned and turned and moved according *the aircraft's* present position and

20   track and speed. On *his* screen *the pilot* see the same landscape positioned in the same manner as the pilot would see it when looking out of *the* windows. All maps and charts can be zoomed. *The pilot* can further select whether *he* wishes only IFR or only VFR maps and charts. A simple 'North up' feature allows *him* not

25   only to read the text on a turned map better, but also to continue positioning in north up configuration of the maps and charts should *he* wish so.
Human interpretation time of navigation instrument readings is drastically reduced, hence enabling faster reaction and a

30   better 'plan ahead'. Navigation errors are omitted.

Additional Information on the ND

In addition the track, position in latitude and longitude, altitude, ground speed, time in UTC, departure, destination and alternate, elapsed time, zoom factor and map scale are

5   displayed simultaneously.

Track Beam:

A track beam enables *the pilot* to verify and fix *the aircraft's* course to any point of interest around *the* aircraft or to

10   circumnavigate heavy weather or danger areas.

Forward Moving Estimate:

It is always a help when a pilot knows in how many minutes and at what time *the aircraft is* overhead a certain position ahead.

15   The Pilot can project *the* remaining flight time and *the* ETO over his map at the point *he* will reach it.

Electronic Cockpit Library:

An Electronic Cockpit Library allows the pilot to display

20   whatever document he wishes to have present; e.g. maps, checklists, airport data, radio aids, meteorology, tables and codes, procedures, entry requirements, AFM and technical manuals (and even hotels and restaurants at the destination or alternate for the comfort of crew and passengers). The number

25   of documents depends on the customers needs and can be custom tailored (Figure 11).

Displays:

The System comes with two fast, full color and lightweight flat

30   panel displays allowing to present any colored, black and white or grayscale image or text. Contrary to today's standard

cockpit CRT's the GIANS-display allows the simultaneous depiction of complex varieties of multi-colored, multi-shaded patterns. Furthermore the GIANS-display has no eye or body harming radiation.

Keyboard:
The keyboard is integrated in the display unit. An external keyboard may also be used. It is user-friendly, simple in handling offering color-coded, clearly arranged functional blocks. There is no need to enter coordinates and therefore there is no chance for erroneous inputs. Night operation is comfortable as well since the lighting of the keyboard blocks corresponds to its daylight colors. It is automatically dimmed with the airplanes instrument panel dimmer allowing *the pilot* the amount of light *he* wants. In case of an airplanes electrical power failure all GIANS-systems continue to work normally on the system-integrated optional battery pack when installed, inclusive the keyboard lighting.

Replacement of Cockpit Instrumentation:
The System is capable of replacing the following Cockpit Instruments and systems: ADF, VOR, HSI, DME, ILS, MLS, RNAV, LORAN, OMEGA, INS, FMS (In accordance with aircraft and engine data and the degree of automation), EFIS, EVS, GPW, EGPW, and, when ATC is ready for it (data up- and downlink to and from aircraft established), TCAS. (FAA considers GNSS as primary navigational means) (Figures 12, 13).
Approach Channel:
A 3-D tunnel-like approach channel (customers option) enables *the pilot* to 'enter' a tunnel that leads *him* safely to the runway while giving a continuous visual 3-D picture of the ILS

limits, *the aircraft's* position, distance to the runway, required altitudes and checkpoint marks, colored marker beacons etc. The approach channel is not limited to ILS equipped airports and can be custom tailored (Figures 8 and 9).

5

Precision Approaches:
The System is equipped with a differential receiver for differential GNSS signal reception enabling satellite based ILS Cat 1, 2 and 3 approaches.

10

Enhanced Ground Proximity Warning and Terrain Profile:
Though *the pilot* sees the terrain on some of *his* maps on the navigation display. *He* may want to be warned if the terrain below and before *he* comes closer than a certain amount which is

15   of a healthy distance. *The aircraft's* flight path is continuously compared with the GIANS internal terrain database. *The* terrain clearance is calculated and graphically displayed together with the terrain height profile on track. *The pilot* will be visually and acoustically warned well in advance if a

20   terrain conflict arises. Furthermore *he* can scan the terrain 360° around *the* aircraft to search for the best terrain clearance. The unique GIANS integrated forward looking EGPW/TP is a great safety aspect and will help to avoid controlled flight into terrain (CFIT) (Figure 14).

25

Future ATC improvements:
The System is prepared for ATC related GNSS based data communication (data up- and downlink to and from the aircraft and between aircrafts), allowing the aircraft to operate in

30   internationally linked automatic air traffic management systems (ATM), omitting expensive ground stations, e.g. RADAR, VOR,

DME, ILS, MLS, NDB, LORAN, OMEGA etc., and of course airways. Separation will be reduced and airspace capacity improved. The link can also be used for collision avoidance in the air and on ground as well as for apron positioning and company related
5   data communication.

Automatic Flight Log:
An automatic flight log stores *the aircraft's* place of departure, date and T/O time and place of arrival, date and
10   landing time as well as the elapsed flight time. This enables the aircraft operator to have access to a complete and precise recording of all flights.
On customer request the log may be extended to a flight recorder whereas all details including keyboard entries are
15   stored and recallable.

ADVANCED PRIMARY FLIGHT DISPLAY:

GIANS represents a complete stand alone flight deck equipment
20   including an advanced PFD with FMS functions and the following fine information and features:
Horizon, compass with automatic deviation and variation compensation, selectable magnetic track, true track or grid, heading bug, automatic direction bug (coupled with an activated
25   flight plan, autosearch or any other navaid), altitude, altitude preselect, ground proximity warning on the altitude scale, vertical speed with vector indicator, true air speed with aircraft limits, ground speed, slip indicator, time in UTC, from/to FMS windows with continental or worldwide database
30   and flight plan coupling, course, distance and estimated time, rotating 'To'-needle (similar to an RMI). ILS indicators or ILS

tunnel guidance. Instrument landing guidance may be taken from
the internal conditioned differential GNSS signals or from
conventional external ILS receivers. The PFD is normally
displayed on the upper screen but may as well be switched to
5   the navigation display (Figure 15).

Further improvements:

SATELLITE WEATHER:

10 After *the pilot* has done *his* preflight weather briefing the
weather may change rapidly and *he* may encounter entirely
different conditions than forecasted. Since weather information
is of greatest importance *the pilot* may want to receive live
and in-flight the newest actual satellite pictures to plan
15 ahead. Wherever *the* position around the world is, in-flight or
on ground, this is possible with the satellite weather option
(Figure 15).

3-D TERRAIN:

20 This exclusive feature allows *the pilot* to see the real 3-D
terrain moving in such a way as the pilot would look out of *the
pilot* cockpit windows. Especially when *the pilot* is in full IMC
or at night it is a tremendous feature of safety (Figure 10 and
11).

25

COMMUMICATION:

This fine feature allows *the pilot* to perform VHF, HF and
SATELLITE short and long distance communication (Figure 16).

30

ENGINE INSTRUMENTS:

This fine feature allows to display jet or piston engine instruments either in analog round type or vertical type presentation (Figure 17).

5

AUTONOMY:

The electric System in an aircraft is nowadays quite reliable. Still there are a few complete electrical failures that happen. Should the pilot want to be on the safe side there is an

10 optional customized battery pack possible that enables to continue normally with all system features for the amount of time *the pilot* regards as sufficient. This makes GIANS to a complete stand alone navigation and flight control system working entirely independent of other cockpit avionics and

15 aircraft power supply.

Software of GIANS:

All these functions are made possible by the integrated GIANS software. These are described with program functions as

20 follows:

The software realizes a navigation system for civilian aviation.

It has been conceived according to the latest knowledge and techniques and has to simply be able to tie future expansions,

25 built up in modular way.

Two industry computers (CPU) serve as a platform on a VME bus base, OS9 as Operating system, different I/O expansions, a keyboard as well as a graphics card for each of the two screens.

30 Each CPU has its own SCSI adapter, which accesses a common hard disk, and each CPU its own Ethernet network board.

The communication between the two, otherwise independent systems, will be realized via UDP reports, bus-like, over the Ethernet cards. Outsiders programs also can use this bus for e.g. logging or test inputs.

5   The same processes run by the majority on the two systems. Some processes, which are needing a specific hardware connection will be started only in the corresponding system. The GPS process to which a GPS is also attached is started only on the system so it behaves similar to air data and keyboard

10 processes.

On the first system (Figure 1, top) primarily is represented a compass for a PFD, the first system artificial horizon, altitude, speed etc.

The second system (Figure 1, bottom) serves as navigation,

15 document and system screen. It can be changed between different display screens.

In emergency cases the two screens can be mixed up to e.g. with the failure of the first screen/graphics map not miss the PFD.

A keyboard, which is arranged around the two screens is

20 available for the interaction with the user (pilot). A second keyboard is optionally conceivable, which can be put in the cockpit someplace.

Different data sources as well as the internal data bases (Maps, Waypoints, ILS path, Terrain) provide the program with

25 the necessary information for the different screen modes (Figure 17).

Configuration:

Every CPU starts itself, OS9 is booted automatically. As

30 "tsmon" a process is automatically started (mymon). After some

seconds waiting period the first user is logged in. To this a file /dd/SYS/password is accessed.

The Login script of the first user initializes the basic variables, among others GIANS. CONFIG, this as the file name which the configuration file specifies.

For every CPU an own configuration file can be specified. These gians1.cnf for the left CPU (PFD) and gians2.cnf for the right CPU (MAP) usually is.

Thereafter the full software is started. These shall not process could e.g. because they aren't needed on the local system be indicated over the command line (e.g. NOGPS NOAIRDATA) get started.

The memory modules get established, loaded (Waypoints, Maps) and the processes started. Thereafter the program is finished.

Program construction:

The GIANS software consists, of different program modules each as a single OS9 process. The modules communicate via common memory areas (data modules) with each other, UDP reports as well as signals.

Since the same processes run in the two systems, the description can be reduced on a single system. Every system can take over the function of the other one.

The configuration file reads [n] .DAT, to carry out fundamental attitudes. Under [n] is to understand the number of the system: 1 = on the left/PFD, 2 = on the right/ MAP.

The program prepares the common memory areas and starts/stops the individual program modules. The modules end themselves as soon as all modules are started and there is no other need for it any more.

The following graphic illustrates the ensemble playing between

the single program modules and the common memory areas (data modules). (Fig. 18)

Data base:

5   In GIANS the disk system is used as a DB system. A separate DB Engine here makes little sense since all search functions (Queries) can be done themselves in the RAM of the main processor and it have to be accessed by single files only.

10 WAYPOINT:
Waypoints are a list of airfields navigation helps (radio beacon VOR, NDB), or also other points of interest (towns, mountains).
All Waypoints have the same structure and are different only
15 with regard to the contents. The whole list of all Waypoints is fed and put down to WPDAT into a data module by the process of start at program start. They are sorted according to names. GIANS finds the Waypoint-file WP file = the new proceedings of [n] .DAT in the configuration file due to the parameter.
20 In the data module they are available for the individual program parts and are read only during the operation.
A Waypoint file is made by means of the PC program NavBase (see PC aid programs) due to user inputs or ARINC files (e.g. of Jeppesen).
25

MAP
All maps in Giant to be displayed first have to be converted into the own format, added by alphanumeric details of and measured before.
30 This is performed by the programs MakeMap and ViewMap. (see OS9-help programs)

The maps consist of a header (MAPHDR) and 1 to 6 zoom steps.
Every zoom step then consists of a own header (ZOOMHDR) on
which the real picture data follows the map. Every pixel covers
exactly one byte in which 6 steps are available per color
5   channel (RGB).

The files are available in uncompressed form at present. There
would be one suitable compression proceedings (JPEG). However
it could be necessary to reduce the amount of data to
accelerate in future.

10   In the MAPHDR information is provided such as the description
of the map, airfield sign, country etc. and also PickingRect
(active map region) with 4 measuring points, which make an
assignment of pixel to geographical position possible.

Information about the single zoom step (breadth, height) is in
15   the ZOOMHDR.

It also has to store place into this for a field around the
last position in the Librarymodus to place it at the next start
so as the user has seen it before.

At the program start all MAPHDR are fed and put down to one
20   data module called MAPDAT by the process of the startup of all
the Maps. GIANS finds the Waypointfile due to the parameter
Map_Dir = [n] .DAT in the configuration file in which several
lists can be indicated. They are at the individual program
parts' disposal and are only to read there.

25

Terrain:
There isn't any fixed format for the terrain data yet. The
representation of the terrain is still in the test phase at
present. Terrain data must certainly be defined by
30   characteristic format with a header, which does describe what
in this file is and the real content one at all.

A program then is needed to prepare the files, too.

Data modules:

5   PROGDAT
    The PID of the individual processes as well as the ID of the
    current processes is summarized in PROGDAT. So a process can
    send to another process a specific signal within the system.

10 FLYDAT
    All data to the current flight situation and position as well
    as program statuses and values calculated are summarized in the
    data module FLYDAT.
    Additionally the attitudes fed by the configuration file .DAT
15 are provided with to FLYDAT in a sub-structure for all other
    processes.
    The individual data sources (GPS/air data) also put hits data
    into own sub-structures of FLYDAT. Information is provided by
    FLYDAT for the further calculation by the program whenever
20 required.
    Every program module uses FLYDAT. It is the most central and
    most important data module within GIANS. In it global, process
    general data are saved.

25 WPDAT
    The data module contains all Waypoints in a sorted order.
    Waypoints generally are points, which are for the navigation of
    interest. Traditionally radio beacons (VOR, DME, BS etc.) are
    described as a Waypoints. In GIANS airfields, towns, mountains
30 and other country markings also can be used as a Waypoints.
    For generating and servicing the Waypoint data base the ms

Windows program NAVBASE was made. It can import Jeppesen data in the ARINC format, completed with own data and can change them into a format for GIANS.

In future also ILS are data for of single runways can be used for the visualization of trace channels.

Waypoints are fed by the module GIANS at the system start. Then they remain unchanged during the complete program execution time. Today waypoints are used only in the PFD. The program module FROMTO serves the choice of Waypoints within the PFD.

In future a flight schedule module is provided, which e.g. can list all Waypoints between a take-off place and an arrival airport automatically.

The maps announced at the new method and documents are saved in a format of one's own, this both reconciles alphanumeric data, position data and also pictures for the individual zoom steps.

The maps are made from TIFF pictures and by the aid program MAKEDAT and measured by the aid program MAKEDAT. Thereafter they are at the disposal in a list of their own for the application. At the start of the program the list searched and all headers of the map files read and stored in the data module MAPDAT. Any time they are available for the automatic or manual map choice.

The data module includes an entry for every map being available with the header of the map file.

The module SELMAP uses the header list as the user can select for either the navigation screen MAP or the document view DOC. Furthermore the module is used at the actual needed map to store intermediately for the displaying.

Program modules

Overview

All program modules get started by the process of GIANS.
However they also can be stopped one by one and started again
without interrupting the whole process. This is necessary only
5   during the development and test phase.
Every program module writes its own PID into the data module
PROGDAT as soon as it started successfully and has been
initialized. Faults can be recognized by the process of start
GIANS. The start process can be interrupted and recorded.
10   Every program module disposes signals of other processes to the
current signal processor.
Signals serve to activate processes (take into the foreground)
and to deactivate or, to end (for test purposes) and to inform
about keyboard entries or other events
15   The modules GPS and the module AIRDATA communicate cyclically
with the corresponding data sources and the module KEYBOARD
reads possible keyboard entries. The information obtained is
sent out as UDP reports on the Ethernet bus where it can be fed
to and used by the module INTERCOMM of the other modules also
20   in the 2nd system.
The central module INTERCOMM processes these reports, makes
calculations and provides the results for the display modules
to the common memory areas. The module is the real coordinating
point for the user interaction and data coordination.
25   The module SEARCH, in the background, searches permanently the
Waypoint data base around that one of the current position of
airfields seeming most reasonable and other Waypoints.
The indices thereof are put down to the common memory areas to
be mostly reprocessed by the display process PFD when required.
30   The module MAPDATA loads a new map or zoom step into the common
memory area MAPDAT (upon request by MAP).

The desired zoom step of the desired map is loaded, starting out from the current position. At completion a signal, which announces the completion, is sent to the display module MAP.

5   It give 2 types of requests:
Quickload: Only a little area is loaded around the current position to be able to build up a display screen as fast as possible.
Normal: A greater area is loaded around the current position.

10

GPS
The GPS process initializes the GPS at the start of the program via the serial connection fixed by the configuration file. The GPS sends reports in the standard format (ASCII) periodically, which are interpreted constantly and stored into the sub-structure Gps (GPSDATA) of the global data module FLYDAT. Depending on mode, other reports are requested from the GPS. Position data are usually required with a higher priority than status data.

20 However, the status screen is active, the frequency of the status reports is increased and the frequency of the position data is reduced, so that the status of the position of the satellites and the reception quality of the individual satellites can be displayed.

25

AIRDATA
The AIRDATA process opens the connection to the AIRDATA computer at program start via the serial connection fixed by the configuration file. The AIRDATA computer sends reports periodically to be interpreted constantly and be put into the sub-structure of AIRDATA of the global module FLYDAT.

The AIRDATA computer finds data out from air pressure and jam pressure as well as other equipment attached externally and transmits it to GIANS

5   MAGNETO

The MAGNETO process opens the connection to the MAGNETO computer at program start over the serial connection fixed by the configuration file. The Magneto sensor sends reports periodically. They are interpreted constantly and put into the

10   sub-structure like (MAGNETO) the global data module FLYDAT. The sensor determines the magnetic horizontal situation of the airplane. If the flight situation is not inclined (lengthways or crossways) the details must be corrected accordingly.

15   INTERCOMM

The process Intercomm 'listens' permanently to the UDP bus, reads all reports and interprets them. The process makes the necessary calculations, activates other processes and serves so as a real central control station of the system.

20

The following reports can be distinguished:
KEY: Keyboard events, a button was pushed
GPS: a GPS report has come in
AIR: a report of the air data computer was read
25   Lied: a logging report was sent: ignored
DBG: a debug report was sent: ignored
MAP: a report of the magnet sensors has come in.

SEARCH
30   That process searches all Waypoints periodically and finds the next 5 airports as well as the nearest waypoints. The data

found are put in the global MemoryModul FLYDAT where they are at the other processes' (mostly PFD) disposal.

MAPDATA

5   it remains inactive till the process activated by the process MAP by means of a signal. This can be the following events: Reload: A map part shall be read and be made available in the global Memorymodul MAPDATA.

In the field SelMap the map to be loaded is specified. In the

10   fields SelZoomPos/SelXPos/SelYPos the desired zoom position as well as specifies map position in the fields gets specified. Calibrate: An offset can be defined in longitude and latitude, which is taken into account at positioning of the map on the screen. Map faults still can be reduced to the running time.

15   The process MAP gives the correction values into the fields SelXcal/SelYcal of the structure.

The process MAPDATA stores these correction values of the corresponding Map file on the hard disk.

Reset Calibration: That function resets the correction values

20   of a map back to 0 again so that the original state is achieved again.

PFD

The PFD process represents the Primary Flight Display (PFD)

25   screen. It contains Altitude, Vertical Speed, Ground Speed, horizon, compass, drift as well as FROM- and TO-Waypoint displays.

The PFD is usually active on the upper screen (left CPU). The

30   process makes use and represents the mentioned instruments from the global Memory module FLYDAT. For the choice of FROM or TO-

Waypoint the independent process FROMTO is used.

The process is divided up into the following different individual modules, which are aware of one isolated function each of one's own.

5   PFD.C is a main module for building windows, drawing of texts and interaction with other processes. It works with 2 windows (double buffering). One is visible while the other is built up. When it is finished, the second window is swapped. This makes a display without flickering.

10 BARS.C R is a representation of a range for TAS and ALT. The ranges are drawn into own windows, which then are displayed in the PFD.

HORIZONT.C The artificial horizon is drawn into a bitmap of its own one and then it is transferred into the current window of

15 the PFD.

ILS.C draw the ILS trace channel into the PFD

ILSDATA.C contain some constants for the representation of vector numbers

KOMPASS.C draws the compass into a 540 degrees wide window,

20 which is placed so that the current direction of flight is visible. Hdg bug as well as To bug are represented on the compass scale.

FROMTO

25 The module serves the choice of Waypoints for the advertisement in the FROM or TO fields of the PFD.

It is built as an own process to not interrupt the display in the PFD while a Waypoint is chosen.

The process INTERCOMM sends the keyboard signal to FROMTO for

30 activating after pressing the button VK_FROM or VK_TO.

FROMTO thereafter opens a window at the appropriate place on the screen in which a users can choose a Waypoint. These are visibly always 4 Waypoints in the window at the same time. The current one is marked by an inverse representation. The user has the following methods for browsing through the list of the Waypoints:

Button up/down for scrolling one entry each up/down

Input of letters to jump on the second, third, fourth or fifth letter or what, within some seconds after the first letter.

By pushing the enter key the current Waypoint is selected and written in FLYDAT.

The same button as for the activation is pressed again (VK_FROM or VK_TO) the FROMTO window is closed without having to make a selection. The window is closed automatically after some time without user interactivity.

In the two cases the previous advertisement in the From/To field of the PFD remains unchanged.

Whether the FROM or the TO-Waypoint should be chosen, the user in addition to the list of the Waypoints is able to choose the following:

FROM:ACTUAL position autom. of the current position

TO: NEAREST POINTautom. to the next Waypoint

FLIGHT PLANautom. to the next Waypoint of the flight schedule (if FPL completed)

MAP

The process MAP usually displays on the lower screen (right CPU) a map on with the current flight position.

The current flight data (course, position etc.), are displayed in a header line and information about the displayed map (zoom position, scale) in a foot line. The map is turned

corresponding to the direction of flight. By the function 'North-Up' a northward directional display also can be forced. The choice of the map is usually carried out automatically with the current position, the current flight status (cab, take-off,

5   flight, trace, cab), as well as the flight mode (VFR/IFR). However, a manual choice also can be carried out by means of the module SELMAP. The user can overmodulate the automatic choice of the maps so.

If it is foreseeable that one is flying out of the current map

10   soon, the background process MAPDATA, which feeds a new map and thereafter informs and activates the process MAP by a signal again. The direction of flight and speed is taken into account. The function CalibrateMap allows the user to fix an offset graphically in x and y direction. Then the offset writes it by

15   the process MAPDATA into the respective Map file.

The MAP program is divided up for reasons of the clarity and partly for historical reasons into the following different modules:

20   MAP.C: Main module, window building, drawing of title and footnote as well as interaction with other processes. It works with 2 windows (double buffering). One is visible while the other gets finished. If the second window is finished and ready they are swapped. This makes a flickering free

25   display possible.
MAP_CAL.C display for calibrating of a map manually by means of a mobile reticule. The correcting values are submitted to the independent process MAPDATA, which writes it into the corresponding MAP file.

30   MAP1.C Display of the map inside a round compass. This view still dates from earlier stages of development of the GIANS

project.

MAP2.C Display of the map inside a rectangular compass. This view still dates from earlier stages of development of the GIANS project.

5   MAP3.C Current display of the map.

MAPCALC.C Calculation functions for the display of the map.

MAPTOOLS.C For reasons of the clarity some functions were moved into this module since they could be used by other, later views. E.g. representation of the airplane symbol, the zoom

10   step etc.

DOC

This module DOC serves the general representation of documents necessarily for the navigation and guidance of the pilot and

15   are helpful (maps, check lists, Meteo information etc.). Therefore it also is described as a Library function.

The current position is not as important as in the MAP display. Every document is filed in the format of the GIANS maps and can be called and displayed by the user freely.

20   All zoom steps already provided by the file are available. In every document there is a zoom step, which takes a document as whole into the screen. If a more exact zoom step is chosen, the rectangle can be selected by means of the arrow buttons and chosen with the enter key for the new desired zoom step.

25   If a zoom step cannot be displayed, scrolling is possible by means of the arrow buttons. Scrollbars on the right/lower picture edge show the dimension and the position of the currently visible part within the complete document.

The choice of the document is made possible by the module

30   SELMAP in the same way as in the module MAP.

SELMAP

The process allows to select a map. This function is used by MAP as well as by DOC. The maps of the current position (MAP) or all maps, listed to country and airfield (DOC) are listed.

5 The user can select a map by means of arrow buttons.

Only those maps are listed, which are corresponding to the desired map type (cab/Departure/Enroute/Approach/Doc) as well as to the flight mode of (VFR/IFR).

The number of the chosen map is written into the global

10 Memorymodul. The process, activated by the SELMAP, will be informed about by means of a signal.

The process can read the chosen map-no from the Memorymodul and display it (respectively request it by MAPDATA).

15 SET-UP

The process permits to carry out attitudes during the air traffic.

The time, deviation augmenters as well as the magnetic variation can be entered. Deviation augmenters are represented

20 in a table for 8 different positions. The button 'G' draws a deviation graphic for full 360 degrees.

The settings are stored in a file, which the names are fixed by the parameter 'CAL file =' of the configuration file. So they are furthermore available.

25

SYSTEM

The process shows inputs received of the different sensor groups.

Magneto values, A/D values, acceleration values as well as

30 details on the GPS reception are displayed.

This display will be activated at the system start until sufficient satellites for the 3D navigation are available. After the view is further switched to MAP.

5   WEATHER
The Weather process is provided for the display of a weather picture, which is received from weather satellites. At the moment only a static picture is taken to the screen and shown (a stored one) from a BMP file (/h0/GIANS/DATA/satbild.bmp).

10
Library STUFF

Overview
Functions of the Library STUFF.L. are need by all program
15 modules.
The Library offers a variety of functions, which are used by the different individual modules.
It is a normal OS9-Library consisting of the individual '.r' modules.
20 The Includefile STUFF.H include almost all definitions and declarations of the individual Library parts.

MODULES.C
Here are some functions, which make the ensemble playing
25 possible of single program modules.
These are functions, which on the one hand permit the Linking and Locking of the single Memory module as well as Debug and Log functions.

30

GDP.C

To standardize the window treatment and platform independently
are served by the functions in GDP.C. The functions permit the
opening of windows to close or hiding, filling windows or,
5   writing text. The graphic functions used are also generally
here.

The function permits the display of texts written in any angle.
E.g. this has been used at the indication of the artificial
horizon the PFD.

10

MATHFUNC.C

Some mathematical functions are summarized in this module. They
are predominantly functions for the conversion of angles of rad
in degree, in 1/10 degrees etc.

15   Furthermore here are the functions, which permits the exact
time measurement in 1 ms dissolving. This is useful for
performance regulations.

STRINGS.C

20   In Strings.c are put the functions for the string treatment.

VCHAR.C

The data in VCHAR.C serve for character-type used everywhere.
For each of the 256 possible characters strokes are defined
25   here, which lines, indicated in pixels exactly, are needed for
a character. These details are used in continuation with
functions in GDP.C so that the dimension and orientation of
texts be drawn as whished, scaled and revolved. The data
originally are from VCS (manufacturer of the graphics maps) and
30   were adapted for the needs in GIANS.

SINTAB.C

The module contains a table with a value for every 1/10 degree, which corresponds to the sin (angle) of * 2^{16}. This is carried out by the MATHFUNC.C to be able to perform fast turns (MAP.C).

5   Aid programs

The program has 4 functions, which are determined by the first call parameter.

START

10   Sets up all memory areas and starts all program parts belonging to GIANS. By further parameters are allowing to exclude single program parts of it. (I.e. START NOGPS starts all processes except for GPS).

15   STOP

All GIANS processes are stopped and the memory areas deleted.

TEST

Serve for testing the system. In a menu single system
20   parameters can be changed or a flight can be simulated by entering the parameters interactively by the keyboard (terminal).

LOGO

25   Serves testing the logo displayed at the program start.

MAKEMAP

MakeMap is a program, the scanned maps in a TIFF or COT format converts into the GIANS format and generates the necessary zoom
30   steps simultaneously.

With MakeMap also the header information, i.e. the alphanumeric information (name, airfield, country etc.), can be edited, which is stored in a map file.

MakeMap is used by the keyboard (terminal) and also distributes

5 a menu to the terminal. It is the only utility to convert map format into the GIANS. A Windows program would desirable.

VIEWMAP

The program serves for measuring the scanned maps, which are

10 processed by MAKEMAP.

For the first parameter it gets the name of an existing Gians Mapfile.

The map is displayed after that. By means of keyboard commands it can be zoomed in and scrolled. Additionally a reticule can

15 be placed exactly and a measuring point can be defined. (i.e. the assignment of pixel to length/breadth can be fixed). Every map has 4 measuring points, also smaller twists can be corrected so.

VIEWMAP is used by the keyboard (terminal) and also distributes

20 a small menu. The first graphics map is always used for the display of the map.

PC aid programs

25 NAVBASE

The program NAVBASE was made for Windows 3.1 x and is able to read Jeppesen Waypoint data in the ARINC format. The Waypoints can be edited and can be exported in the format of GIANS (OS9). The program therefore can care for the stock of Waypoints.

30

The program for Win32 permits to send keyboard entries by UDP reports, so that the GIANS flight program treats them like if they had been sent by the real keyboard. The complete keyboard is shown on the screen and single buttons can be pressed by the

5   mouse. Exiting single programs by means of menu order is possible.

UDP

The program for Win32 permits to listen for and to record UDP

10   reports on the GIANS -Intercomm bus. It can already stored sequences of UDP reports read back again so that former conditions can be comprehended.

Development system

15

PC

the PC program OS9.EXE was made to write on the PC with any program editor and to have compiled by means of a customary Make utility.

20   It runs under Windows NT 4.0. With it, program modules, which has been changed be sent to the OS9 system and be compiled there.